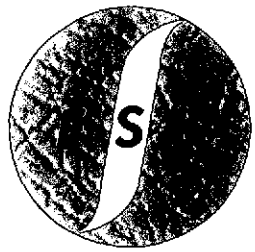

FINAL DESIGN REPORT
EARTH RESOURCES SENSOR DATA HANDLING SYSTEM: NASA JSC VERSION

29 April 1974

Prepared in Response to
Contract No. NAS 9-14077

ESL INCORPORATED

ELECTROMAGNETIC SYSTEMS LABORATORIES
495 JAVA DRIVE • SUNNYVALE • CALIFORNIA

ESL-SR132
Copy No.

ESL INCORPORATED
Electromagnetic Systems Laboratories
Sunnyvale, California

Special Report
ESL-SR132

29 April 1974

FINAL DESIGN REPORT
EARTH RESOURCES SENSOR DATA HANDLING SYSTEM:
NASA JSC VERSION

Prepared in Response to Contract No. NAS 9-14077

This Document Consists of 21 Pages

Copy No. of 20 Copies

CONTENTS

ILLUSTRATIONS

FINAL DESIGN REPORT

EARTH RESOURCES SENSOR DATA HANDLING SYSTEM: NASA JSC VERSION

1. INTRODUCTION.

This document is the Final Design Report for the NASA Johnson Space Center (NASA JSC) version of the Earth Resources Remote Sensor Data Handling System. The conclusions and findings contained in this report are the result of an intensive joint study by both ESL and JSC personnel.

Section 2 defines the specific fields or data acquisition parameters and computer display formats to be cataloged at NASA JSC and used in subsequent retrieval requests. Section 3 discusses the flow of image data through the system from mission planning to information retrieval and presents recommendations for improving overall system efficiency. Section 4 recommends modifications to existing data handling procedures, which will allow utilization of data duplication techniques and the accurate identification of imagery. Staffing requirements for operation of the Data Handling System are discussed in Section 5.

2. DATA ACQUISITION FIELDS AND FORMATS.

The specific data acquisition parameters to be cataloged and indexed by the NASA JSC version of the Data Handling System are presented in Table 2-1. This table lists the name of each field, abbreviation, computer display format, a typical entry, valid field ranges, source data document and identification of the person responsible for resolving conflicts and errors.

The major change to the existing NASA ARC Data Handling System is the addition to the overall data base structure the concept of "mission." A mission is defined as a collection of flights, and, as a result, imposes a higher level of structure onto the data. Unique flight, roll and frame parameters, important for monitoring and control functions, will be formed by a concatenation of each of these fields with the mission number; the later, representing a new field, input once for each roll.

The Image Selection System will be modified to allow searching or limiting on the field concatenation described in the preceding paragraph. The first of these is MISSION-FLIGHT (MF) which is a concatenation of mission number and flight number. Thus, if one wanted to limit a search to Flight 28 of Mission 206, MF=206028 would be used. The same concept is employed for MISSION-ROLL (MR) where MR=206010 uniquely

Table 2-1. NASA JSC Data Fields

#	FIELD NAME	FIELD ABBREV.	COMPUTER FORMAT	EXAMPLE	FIELD RANGE	C&I FIELD SOURCE	FIELD CONTROL/ EDITING RESPONSIBILITY	COMMENTS	NASA STANDARD CODE TABLE
1.	MISSION NO.	MI	MMM	258	001-999	PHOTOGRAPHIC FLIGHT LOG	MISSION MANAGER IN MISSION DIRECTIVE	MISSION NUMBER IS UNIQUE MISSION-FLIGHT IS UNIQUE MF=MN//AF	NO
2.	AIRCRAFT FLIGHT	AF	FFF	004	001-999	PHOTOGRAPHIC FLIGHT LOG	MISSION MANAGER FROM FLIGHT ENGINEER	AIRCRAFT FLIGHT NUMBER IS UNIQUE WITHIN A MISSION	NO
3.	FLIGHT DATE	FD	YYDDD	74036	60001-99366	PHOTOGRAPHIC FLIGHT LOG	SYSTEMS MANAGER IN SYSTEMS MANAGER LOG	JULIAN DATE (GMT) OF TAKE-OFF	NO
4.	EXPANSION								
5.	PLATFORM	PL	PPP	003	001-000	PHOTOGRAPHIC FLIGHT LOG	MISSION MANAGER IN MISSION DIRECTIVE	DERIVED FROM LOG DATA	YES
6.	ROLL	RO	RRR	045	001-999	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	ROLL NUMBER IS UNIQUE WITHIN A MISSION MISSION-ROLL IS UNIQUE MR=MN//RO	NO
7.	SENSOR ID	SI	SSS	006	001-999	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	DERIVED FROM LOG DATA	YES
8.	FORMAT	FO	FF	01	01-99	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	DERIVED FROM LOG DATA	YES
9.	FILM TYPE	FT	TT	08	01-99	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	DERIVED FROM LOG DATA	YES
10.	FILTER	FI	FFF	014	001-999	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	DERIVED FROM LOG DATA	YES
11.	SPECTRAL LOW	SL	LLLL	0510	0000-9999	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	NOMINAL BANDPASS (10% TRANSMISSION) IN NANOMETERS	NO
12.	SPECTRAL HIGH	SH	HHHH	0900	0000-9999	PHOTOGRAPHIC FLIGHT LOG	AERIAL PHOTOGRAPHER	DERIVED FROM LOG DATA BY DATA ENTRY SUPERVISOR	
13.	ENTRY DATE	ED	YYDDD	74057	60001-99366	DATA ENTRY TECHNICIAN	DATA ENTRY TECHNICIAN	JULIAN DATE OF ENTRY	NO
14.	EXPANSION								
15.	STEREO	ST	S	2	1-2	PHOTOGRAPHIC FLIGHT LOG	DATA ENTRY SUPERVISOR	MONO OR STEREO COVERAGE (60% OR GREATER)	YES
16.	MAP BASE	MB	MM	03	1-99	DATA ENTRY TECHNICIAN	DATA ENTRY TECHNICIAN	MAP BASE DATA USED FOR INDEXING	YES
17.	EXPANSION								
18.	FRAME	FR	FFFF	0132	0000-9999	FILM TITLING PHOTOGRAPHIC	TITLING SUPERVISOR/ SCREENING SUPERVISOR/ DATA ENTRY SUPERVISOR	CONTROLLED TITLING IS REQUIRED AC = MN // RO // FR	NO
19.	BROWSE NO.	BN	MMMCBBBB	25820924	00110001-99999999	PHOTOGRAPHIC FLIGHT LOG	SCREENING SUPERVISOR/ DATA ENTRY SUPERVISOR	PREASSIGNED AND REVIEWED BY DATA ENTRY SUPERVISOR	NO
20.	TIME	TI	HHMMSST	1416034	0000000-2359529	FILM	DATA ENTRY TECHNICIAN	GMT	NO
21./ 30.	COORDINATES	CN TL,TR BR,BL	DDDMMT	121467	000000-359599	DATA ENTRY TECHNICIAN	DATA ENTRY SUPERVISOR	COMPUTED FROM DIGITIZED IMAGE – MAP POINTS	NO
31.	SCALE	SC	SSS	128	000-999	DATA ENTRY TECHNICIAN	DATA ENTRY SUPERVISOR	COMPUTED FROM DIGITIZED IMAGE – MAP POINTS	NO
32.	ATTITUDE	AT	A	1	1-3	DATA ENTRY TECHNICIAN	DATA ENTRY SUPERVISOR	VERTICAL, LOW OR HIGH OBLIQUE	YES
33.	QUALITY	QU	Q	1	1-4	SCREENING REPORT/DATA ENTRY TECH.	DATA ENTRY SUPERVISOR	SUBJECTIVE QUALITY RATING EXCELLENT – POOR	YES
34.	CLOUD COVER	CC	CC	04	00-10	DATA ENTRY TECHNICIAN	DATA ENTRY SUPERVISOR	ESTIMATED CLOUD COVER IN TENTHS	NO
35.	ALTITUDE	AL	AAAAA	06510	00000-99999	PHOTOGRAPHIC FLIGHT LOG	SYSTEMS MANAGER IN SYSTEMS MANAGER LOG/ DATA ENTRY SUPERVISOR	ALTITUDE IN TENS OF FEET	NO
36.	RESOLUTION	RE	R	2	1-9	PHOTOGRAPHIC FLIGHT LOG	DATA ENTRY SUPERVISOR/ DATA ENTRY TECHNICIAN	NOMINAL RESOLUTION CATEGORY DERIVED FROM LOG DATA	YES
37.	SEQUENCE NO.	SE	SSSS	0132	0001-9999	DATA ENTRY TECHNICIAN	DATA ENTRY SUPERVISOR	COMPUTED AS AN INTERNAL SYSTEM CHECK	NO
38.	COORDINATE ENTRY METHOD	CE	C	1	1-5	DATA ENTRY TECHNICIAN	DATA ENTRY SUPERVISOR	COORDINATE ENTRY METHOD IS ACCOUNTED	
39.	EXPANSION								

2. -- Continued.

identifies one specific roll (Roll 10 of Mission 206) in the entire data base. ACCESSION-NUMBER (AC) which equals *mission number* plus *roll number* plus *frame number* (AC=MN//RO//FR), represents the final extension of this concept at the frame level.

It will still be possible in the ISS to limit on Roll Number (RO), Aircraft Flight Number (AF), and Frame Number (FR). These will be meaningful search parameters if the analyst has already limited the data base to one mission.

3. DATA FLOW.

The timely and efficient flow of the physical film and supporting documentation through the entire ERAP/EREP task efforts at NASA JSC is an important factor and will materially influence the efficiency of the Data Handling System. A review of the existing data flow was conducted with JSC personnel. The result of this review is a recommendation for a pre-title screening task. This modified data flow is depicted in Figure 3-1. During the pre-title screening a detailed set of instructions for titling the imagery for each flight will be prepared (see section 4.0).

4. RECOMMENDED NASA JSC PROCEDURAL CHANGES.

Two procedural changes are recommended. The first involves the controlled titling of multispectral imagery; the second is the assignment of microfilm browsefile numbers which directly reflect the mission concept of NASA JSC data collection.

The former will require additional time in specifying the titling of the multispectral imagery. It is estimated that an additional hour will be required to title the film for each multispectral camera system. Failure to control the titling will result in an increase in data plotting time proportional to the number of rolls contained in each multispectral camera system. For example, the use of a four band system, will result in a 400 percent increase in cataloging and indexing time (where one roll of approximately 150 frames requires about 5 to 6 hours of data plotting time).

The change in the browsefile numbering system and procedures will result in a more rapid turn-around and will allow retrieval of recently collected imagery in a shorter time than with the present system.

4.1 Titling Requirements.

In order to achieve maximum efficiency from the Data Handling System, it is essential that individual frame titling be accomplished in an accurate manner according to a specific set of rules. Two areas are impacted by titling procedures and accuracy.

4.1 -- Continued.

The first of these is the initial capture or entry of multispectral imagery into the data base. If titling congruency is maintained on all multiband cameras, only a master roll is plotted using the Data Entry System. All other rolls are plotted by internal software routines which equate the coordinates of each frame from the master roll to the corresponding frames of all secondary rolls.

The second area affected by titling procedures and accuracy is the assignment of browsefile numbers. Browsefile numbers should be entered into the computer at the time of data entry. This requires that they be preassigned; and assumes that titling has been accomplished according to the convention described in this section. It is very important that no discrepancies exist between roll-frame numbers and browsefile numbers. Mismatched browsefile/roll-frame numbers will be evident in the Image Selection System and materially degrade the utility of the entire system.

4.1.1 Procedures.

All multispectral imagery must be titled congruently by location. That is, if frame 10 on roll 65 covers a specific location, frame 10 on roll 66, 67, and 68 should also cover the same location.

It is recommended that the following steps be instituted to insure accurate image titling.

4.1.1.1 Initial Screening (Pre-Titling).

Immediately after photographic processing, the multi-band imagery should be screened by a knowledgable person and specific instructions written for titling that batch of film.

4.1.1.2 Final Screening (Post-Titling).

In addition to current quality control tasks accomplished in final data screening, it will be necessary to insure that the imagery is correctly titled in accordance with the instructions previously set forth. If the titling is not correct, the imagery should be retitled.

4.1.2 Titling Guidelines.

If no malfunctions have occurred and all rolls are equal in length, each aerial photograph will be assigned one number starting with 001 and ending at nnn. A simple check of the last frame on each roll to see that the same location is imaged and that each has the same frame number is sufficient. If the rolls are not all the same length, the longest roll is titled in the nnormal manner. If one or more rolls are shorter, in the sense that they ran out of film, the last frame on the short roll(s) should depict the same location and be titled with the same frame number as the master roll.

4.1.2 -- Continued.

Blank frames, double exposures, and frame stacking all require inspection to insure matching frame numbers.

Examples of typical situations are shown in Figures 4-1 through 4-4.

4.2 Browsefile Numbers.

It is recommended that browsefile numbers be assigned by the Data Entry Supervisor (see Section 5) prior to the original film microfilming by Eastman Kodak. As previously discussed, browsefile numbers are derived from the frame-by-frame titling performed by the Phototechnology Directorate at NASA JSC.

The recommended numbering system and procedures utilize elements of existing systems employed by NASA ARC and JSC. For JSC, the browsefile number will consist of eight characters in the following format: MMMCBBBB. The first three digits will be the mission number, the next digit the cassette number within the mission, and the last four digits the blip count put on the film by Kodak. To accomplish this, it will be necessary to maintain a log book for purposes of preassigning browsefile numbers. When the first rolls of a mission are processed and titled, one roll of each camera type is selected for the browsefile. (This should be the same roll selected as the master roll for plotting.) Additional rolls from subsequent flights are

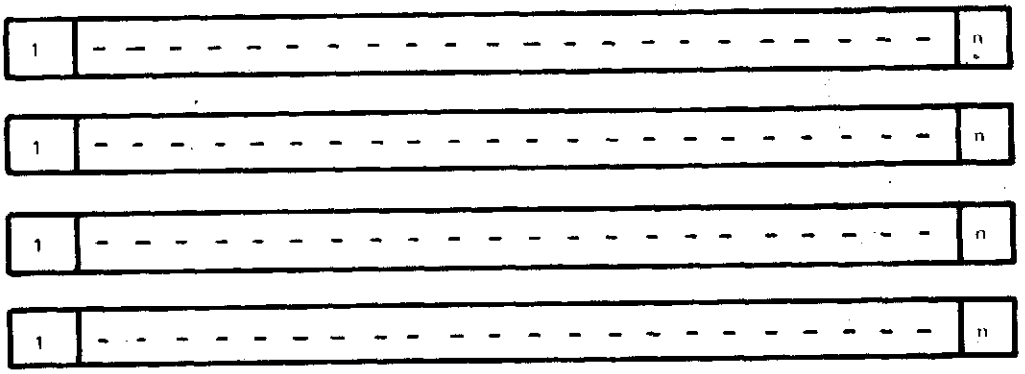

Figure 4-1. All Congruent Titling; No Malfunctions

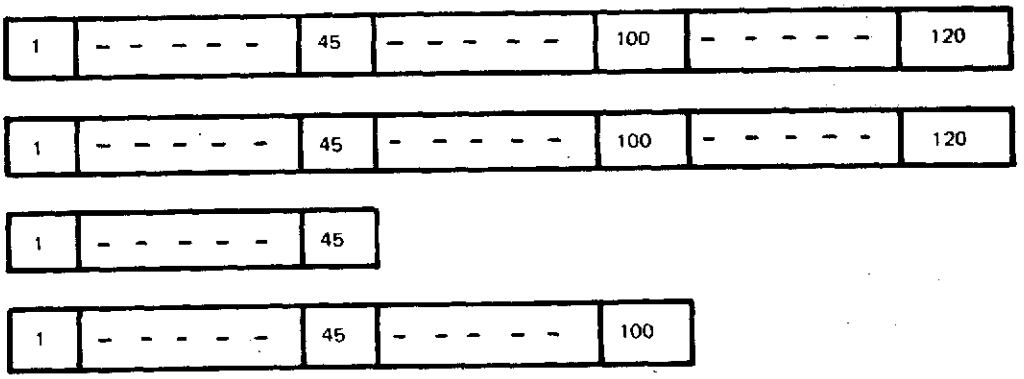

Figure 4-2. All Congruent Titling; Short Rolls

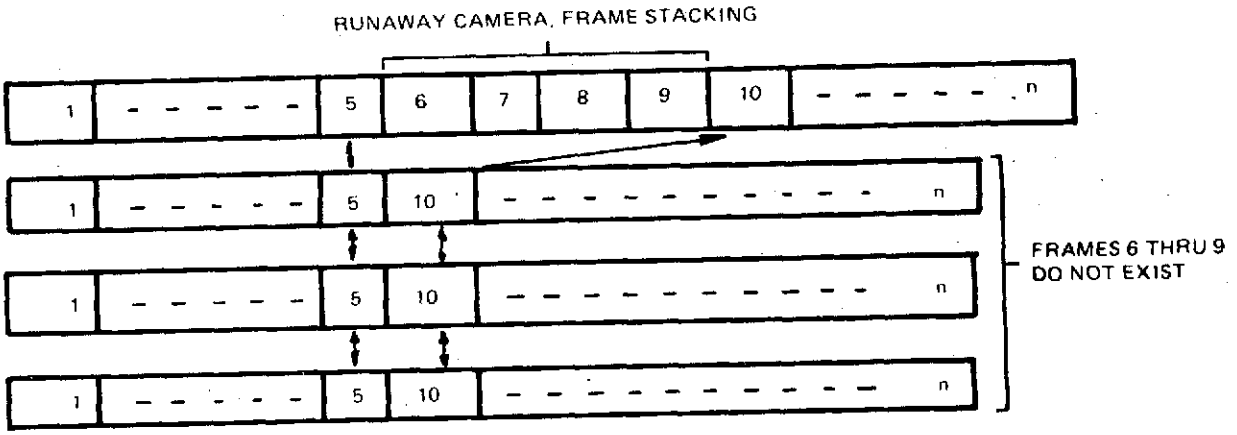

Figure 4-3. All Congruent Titling - Long Roll, Frame Stacking

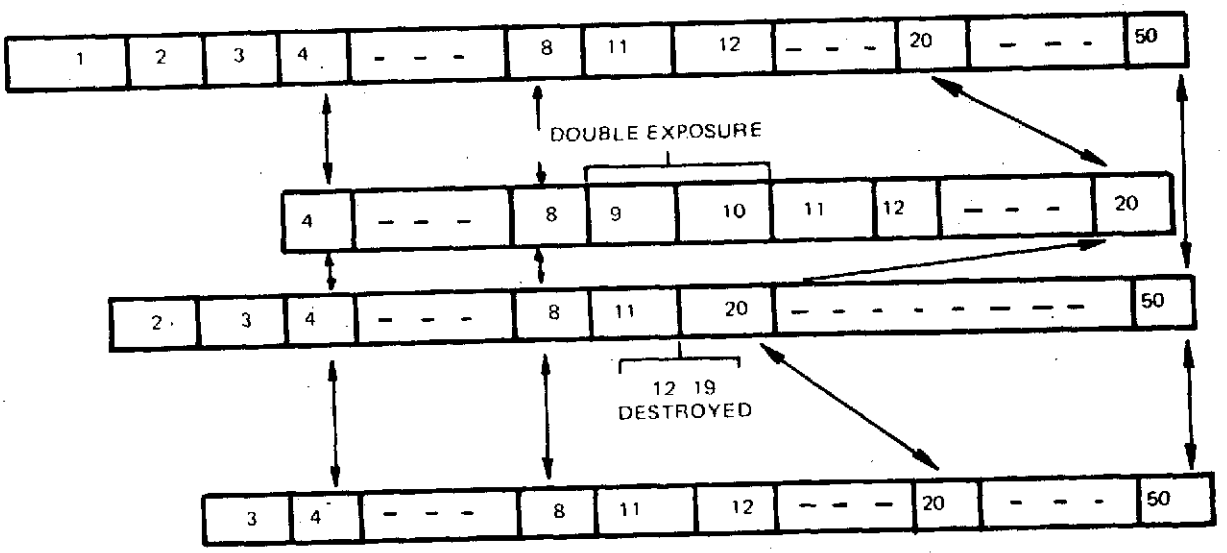

Figure 4-4. All Congruent Titling - Complex Malfunctions

4.2 -- Continued.

assigned sequential browsefile numbers, until the last roll added totals less than 2,000 browsefile numbers.* If more rolls of imagery exist on the mission, a second cassette is started and so forth until all data on the mission has been assigned browsefile numbers. The log book will represent the key source record for assigning the next browsefile number. All multispectral imagery will be assigned the browsefile number of the master roll even though no physical microfilm record exists.

Implementation of this procedure will require an additional check to insure that Kodak physically microfilms the imagery in accordance with the predetermined number. If a physical check reveals errors the imagery should be returned to Kodak for remicrofilming.

The advantage of this system is that each image in the data base will have a unique browsefile number which can be displayed on the Tektronix CRT and viewed on the microfilm viewer.

If necessary, the "preset" system presently used by NASA JSC can be accommodated within the proposed system. The browsefile number of each leader frisket on each roll can be determined and this, in effect, becomes the "preset number" of that roll of film. By initializing the microfilm IC5 control unit with that number and searching on a roll, direct roll frame numbers are displayed on the microfilm control unit.

*One cassette will hold 2,000 frames of imagery.

5. OPERATIONAL TASK REQUIREMENTS.

Figure 5-1 presents a functional organization based upon major task areas within the Data Handling System. The specific duties and job-task descriptions are described in the following section. It is possible and may be necessary to tailor the specific job descriptions to more closely reflect present NASA JSC organizational structure. The purpose of this section is to identify all essential tasks to efficiently support the Data Handling System. If several organizations are involved with different aspects of the Data Handling System it is essential that coordination/communication links be established and maintained.

5.1 Task-Job Descriptions.

The following descriptions are keyed to Figure 5-1.

5.1.1 Data Handling Systems Manager/Support Staff.

The Data Handling Systems manager/support staff are responsible for the entire Data Handling System.

a. Coordinating procedural changes; assess impact,

b. Knowledgeable about details of data handling software,

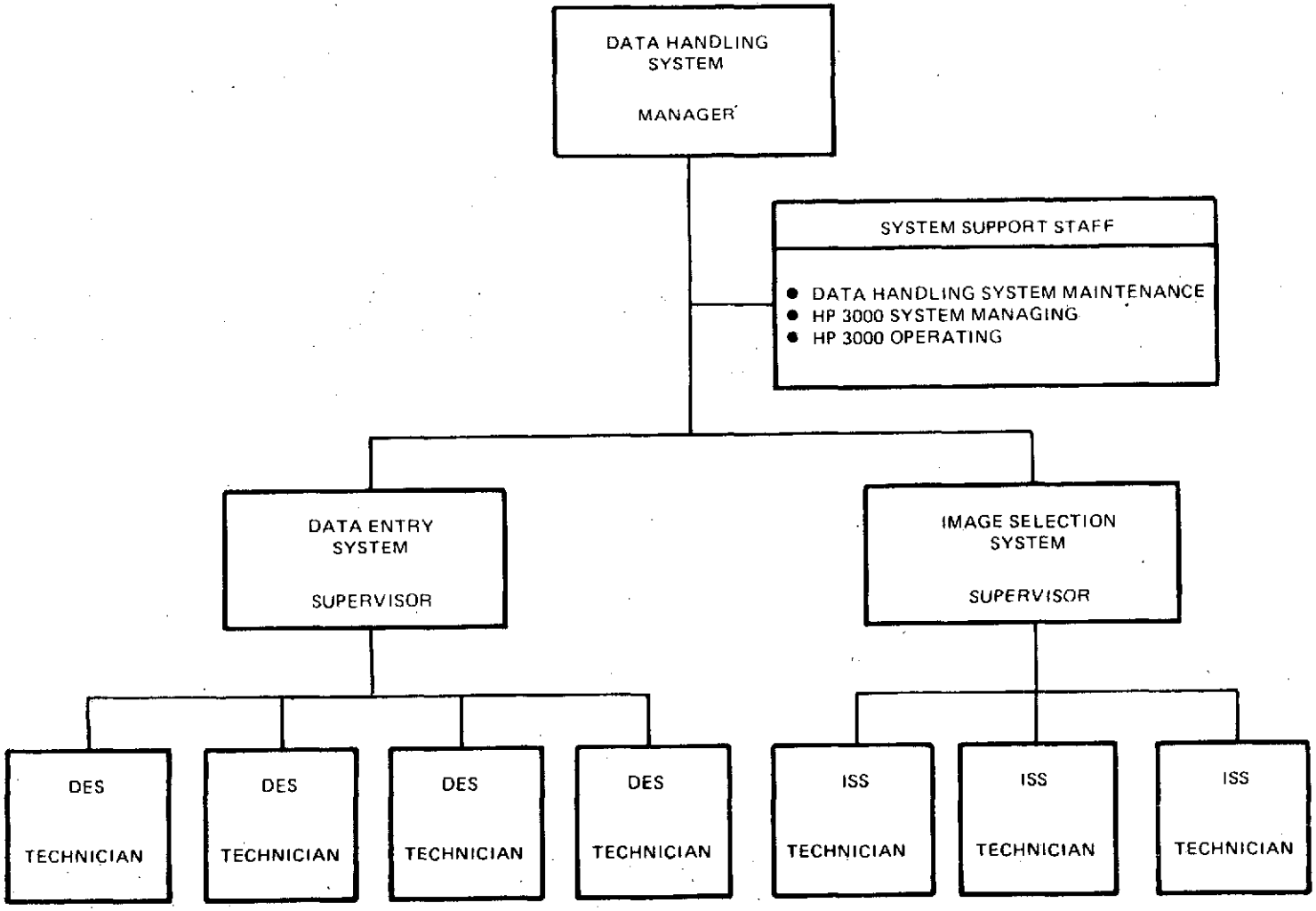

Figure 5-1. Data Handling System Operations

5.1.1 -- Continued.

c. Data Handling System maintenance:

1. Backup functions
2. Master tape creation
3. Software maintenance,

d. HP-3000 systems management and operation,

e. Responsible for overall data base integrity,

f. Interface with NASA/ARC and U.S. Department of Interior EROS Data Center.

5.1.2 Data Entry Systems Supervisor.

The Data Entry Systems supervisor is responsible for generation and integrity of data base.

a. Coordinates with flight operators and Data Handling Systems manager,

b. Functional knowledge of data entry software,

c. Collation of all source information on mission-flight-roll for data entry purposes,

d. Resolves data source conflicts,

5.1.2 -- Continued.

e. Assigns browse file numbers and verifies microfilm,

f. Prescreens imagery for titling and post-screens titled imagery,

g. Directly supervises data entry,

h. Responsible for final data entry editing and quality control,

i. Notify Data Handling Systems manager of completed rolls.

5.1.3 Data Entry Technician.

a. Recheck and verify flight roll parameters,

b. Plot individual frames,

c. Assign frame quality cloud cover and altitude,

d. Edits necessary fields on entered data.

5.1.4 Image Selection Systems Supervisor.

The Image Selection Systems Supervisor is responsible for servicing requests for NASA JSC aircraft and satellite imagery.

a. Coordinates retrieval functions with Data Entry supervisor and Data Handling Systems manager,

b. Establishes service request procedures,

c. Assigns retrieval task orders to ISS technicians,

d. Functional knowledge of Image Selection System software,

e. Overview knowledge of Data Entry operations.

5.1.5 Image Selection System Technician.

The Image Selection System Technician is responsible for servicing individual request for imagery.

a. Functional knowledge of Image Selection System software.

5.2 Coordination With NASA-ARC.

To maintain a NASA wide remote sensing data handling system responsive to both NASA JSC and NASA ARC, it is important to maintain communication between JSC and ARC regarding the addition of new sensors, film combinations, formats, etc.

Advances in data handling concepts and improvements to the system should also be considered from an overall NASA viewpoint. The efficiency of an overall system will be greatly enhanced if supported by both NASA JSC and NASA ARC.